

2016 INTEGRATED RESOURCE PLAN

Seattle City Light *Keeping the Lights on for Years to Come*

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INTRODUCTION

Seattle City Light has provided its customers with reliable, safe and affordable clean energy since 1910. As the utility continues this work and plans for the future, it must account for the power supply demands of its growing customer population and also the increasing trend of energy efficiency.

Seattle City Light and the citizens of Seattle with their shared environmental values continue to make the utility a national leader, balancing power supply needs with the environmentally friendly power supply resources required to meet those needs. Seattle City Light has been a consistent voice for generating electricity with clean renewable resources and promoting energy efficiency with its customers, limiting negative impacts on the environment and reducing the need for costly new power generation. Since 2005, City Light has been greenhouse gas neutral – the first electric utility in the nation to achieve that distinction.

Seattle City Light's 2016 Integrated Resource Plan (IRP) outlines how the utility will meet anticipated customer needs under changing market dynamics, evolving policies and future uncertainties over the next 20 years. The IRP requires a constant review of conditions which affect its power supply needs, costs and risks. These considerations include evaluation of energy efficiency potential and new resource opportunities to ensure the utility's reliability, environmental stewardship, and Washington State mandated renewable resource requirements are achieved.

The IRP is created as part of good utility practice and is developed with guidance from the Mayor, City Council, and legislation from Washington State. State law requires electric utilities to develop IRPs and provide them to the Washington State Department of Commerce every two years.



The basic job inherent in developing an Integrated Resource Plan is:

- Forecast the energy and capacity needed to meet customer demand.
- Determine the utility's capability to supply those needs and ensure flexibility for when those needs fluctuate.
- Define the capability and cost of current and prospective resources.
- Evaluate potential future City Light portfolios based on reliability, cost, risk and environmental impact; and recommend a plan.

To decide whether the utility needs to alter its mix of resources, it does rigorous research, forecasting and analyses and considers input and feedback from technical stakeholders, customers, the Mayor, and City Council.

City Light reported its findings to the City Council for the 2016 IRP review. After a public hearing in front of the Council's Energy and Environment Committee, the full City Council passed the 2016 IRP and its recommendations on August 1, 2016.

City Light: Way Back in the Beginning

On March 4, 1902, three-fifths of Seattle voters approved \$500,000 in bonds to fund construction of a municipal hydroelectric dam and plant at Cedar Lake. The project was entrusted to the Seattle Water Department and a young engineer named James D. Ross (1872-1939). The Seattle Lighting Department, or City Light, was created in 1910 and Ross became its superintendent in 1911 and held the post until his death in 1939.



A municipal power plant was not a common idea in those early days, but due to growing resentment of private interests controlling electrical services and streetcars, voters consistently sided with public ownership advocates through a series of additional bond elections. Ross is credited with decisions that built City Light with ample electricity capacity that has lasted a century. The reigning in of the area's vast hydro supplies as a Municipal utility is considered one of the best investments passed on from Seattle forefathers. The new Cedar Falls power plant began delivering power to Seattle on January 10, 1905.

EXECUTIVE SUMMARY

The Integrated Resource Plan (IRP) is Seattle City Light's 20-year forecast of what electricity demands its customers will have and what mix of resources will best meet these needs. The four evaluation criteria used in this IRP are reliability, cost, risk and environmental impact. The 2016 IRP reflects the results of the past two years' research, planning and analyses to reassess customer demands, to review generation needs, and to consider market conditions and evolving policies and regulations.

KEY RECOMMENDATIONS: The 2016 Integrated Resource Plan recommends staying the course with energy efficiency, hydro and renewable resources as outlined in previous plans. While the region is growing, customer energy demand is expected to grow at a pace lower than forecasted in prior Integrated Resource Plans. As a result, City Light does not forecast any new power supply resource additions for the proposed 20 year timeline as a result of increased customer demand. The study does show minor changes in its resource additions resulting from the replacement of contracts that are expiring. It also shows that in most cases demand growth can be met cost-effectively with new energy efficiency programs. This does not mean that the circumstances could not change, City Light will continue to evaluate every two years whether its plans should be altered.

The current two-year action plan recommends City Light continue supporting programs to reduce energy use as its primary path in meeting the forecast demand and forestall new generation development. The IRP action plan also calls for monitoring technology options, as they develop, to determine the most cost-effective means to meet customer needs.



KEY FINDINGS

■ **Seattle City Light expects continued modest load growth despite the building surge visible in the utility's service area.**

Over the course of the Integrated Resource Plan's 20-year study, City Light expects to experience modest average annual load growth of about 0.4% under conditions of normal weather and before the impact of City Light sponsored energy efficiency programs available to its customers. This demand growth is at a slower pace than in the past. Despite the visible construction, there is no dramatic jump in expected power needs. The reason can be tracked to a customer base which has increased its energy efficiency, ever-improving technological efficiencies and stringent building codes.

New energy efficiency programs are not included in the above forecast, because they are considered one of the energy supply resources that City Light considers as part of the Integrated Resource Plan. Overall, City Light's energy efficiency programs protect the environment and act as a major supply resource – they save customers money by avoiding the cost of building several large power plants. The recommended pace of new City Light sponsored energy efficiency programs is forecast to meet all projected growth in electric demand during the 20-year study.

■ **Seattle City Light should continue its pursuit of cost-effective new energy efficiency.**

Energy efficiency through new energy efficiency programs and targets is considered to be the resource of choice. The 2006 statewide citizens' Initiative 937 (I-937), "The Energy Independence Act" requires utilities to add cost-effective energy efficiency and renewable resources to meet a portion of load. Future energy efficiency programs included in this IRP are forecasted to be more cost-effective than available renewable resources for meeting the remaining power supply needs. The recommended portfolio in the 2016 IRP continues a high energy efficiency strategy. As a consequence of reducing load, energy efficiency also reduces the amount of renewable resources and renewable energy credits (RECs) the utility must add to comply with I-937.

■ **City Light can expect to meet its power supply needs without adding costly new generation resources.**

For the next decade, City Light expects to meet its resource needs with a combination of its existing resources, its new energy efficiency programs, use of generation flexibility in existing hydro resources, and short-term wholesale market purchases as deemed reliable and necessary.

The significant increase in power supply resources shown in the 2016 IRP in 2028 compared to the 2012 IRP and the 2014 IRP update comes from including an assessment of the expiration of City Light's power purchase contract with the Bonneville Power Administration (BPA). The IRP analysis shows that to meet its obligations to be a reliable, environmentally responsible and cost-effective utility, a new BPA contract is expected to be part of the preferred resource portfolio along with additional renewable resources.

■ **Seattle City Light should continue to add renewable energy credits and renewable resources as necessary to meet renewable portfolio standard (RPS) requirements mandated by I-937.**

In 2020, City Light's RPS requirement jumps to serving 15% of annual load with eligible renewable generation from its current level of 9%. Based on the existing renewable mix in City Light's resources portfolio and previously acquired RECs, the utility expects to meet its RPS obligations through 2023. Because City Light does not have power supply needs before 2028, RECs are expected to be the most cost-effective way to satisfy I-937.

■ **The utility should continue to seek existing and new opportunities to maximize economic benefits from its clean and reliable hydro resources.**

City Light's flexible and abundant hydro resources gives it an ability to withstand fluctuations in energy demand and supply and have surpluses to sell in the wholesale energy markets. City Light will continue to maintain its strategic resources sell its surplus power to offset the cost to serve demand, purchase power when needed, and explore new market opportunities for reliability and economic benefits.



- **Seattle City Light has been a leader in environmental stewardship for more than 30 years, making it ready – even a model – for responding to the increased impacts and changes which may be caused by climate change.**

City Light has instituted energy efficiency programs for almost four decades, and its energy efficiency goals are nationally respected. With its abundant hydropower resources, the utility is committed to the protection of aquatic ecosystems and fish and wildlife habitat, environmental education, and maintaining the beauty and recreational opportunities that are critical to the quality of life in the Northwest. Additionally, the utility is one of the first in the country to attain carbon neutrality and is a leader in studying its climate vulnerability.

City Light's 2016 Integrated Resource Plan includes an early review and analysis of climate change impacts on City Light's water resources used for electricity generation and for meeting electricity demand. The future projected climate change impacts appear similar to changes City Light already has encountered due to severe weather fluctuations, dramatic shifts in market conditions, emergency conditions, or other circumstances faced in the past. What is changing today is the formulation of specific climate change legislation, policies and plans which have been promulgated recently or are in the works nationally, regionally, and locally.

City Light offers reduced price, energy efficient LED light bulbs for sale at participating retailers, <http://www.seattle.gov/light/homelightning/>. Each year City Light customers who attend public meetings or work on special projects for energy efficiency or education are often given LED light bulbs as tokens of appreciation for their time and work.



PUBLIC INVOLVEMENT

Over the next 20 years, City Light will track its power supply needs, new and traditional resources and I-937 compliance choices. These power supply choices require investing hundreds of millions of dollars of customer funds, as well as dramatically affecting future operating costs, reliability and the City's environmental footprint for decades to come. As a publicly owned utility, customer input on the Integrated Resource Plan is essential.

City Light conducted three IRP stakeholder meetings and one webinar with representatives that included customers, environmental organizations, regional energy related governmental organizations, and academic specialists.

In addition, City Light shared information and collected comments about its IRP process through its website, social media, neighborhood council meetings, and a live and interactive Public Online Open House, which is available for viewing on the IRP website.

In summarizing the views of the stakeholder and public participants, their commitment to the environment is clear.

- 1) There is broad support for an aggressive environmental stewardship program.
- 2) The focus continues to be the investment by the utility in the aggressive pursuit of energy efficiency with an interest in how new technologies such as solar, electric vehicles and other distributed resources may impact the utility and how the utility interacts with customers in the adoption of these resources.

But public participation in meetings is not the only way City Light customers show their preference for power supply resources and production. Its customers are active participants in taking steps offered by the utility to show their environmental stewardship. Customers and City Light advance these initiatives together through:

- 1) Programs offering discounted light bulbs at local stores resulting in hundreds of thousands of new LED light bulbs being installed every year.
- 2) Four community solar projects sharing the benefits of solar energy with a wide range of customers.
- 3) Public participation in the Green Up program where customers voluntarily add extra money when paying their electric bill to be used for educational and demonstration projects to support renewable resource development.
- 4) Plans to install public electric vehicle charging stations as Seattle continues to lead the country in transforming renewable energy to electric fuel for cars.
- 5) Salmon, steelhead and bull trout fish habitat restoration and water quality programs which are continually advocated for by customers.
- 6) Support for new building codes every time new technologies are developed and proposed, making Seattle the city with one of the highest standards for energy efficient growth.

PLANNING AND REGULATORY REQUIREMENTS

City Light's goal is to exceed customer expectations in producing and delivering power that is environmentally responsible, safe, affordable and reliable. Since 2005 City Light has been a greenhouse gas neutral utility. In planning for the future, it does this in the backdrop of a complex industry, new technological advances, and changing policies and regulations.

City of Seattle Policies and Regulations

City Light has a 30 year plus history of environmental stewardship with policies, programs and planning efforts driving how the utility makes decisions. Environmental and climate protection initiatives are woven throughout several City policies.

Climate change is not a stand-alone issue separate from the other issues that the City faces. It is rooted in land use, transportation, energy use and consumption patterns that have evolved over generations.

In 2000 City Council passed a ground breaking resolution (30144) that established City Light as a global leader in climate protection. It was the basis for City Light to meet load growth with cost-effective energy efficiency and renewable resources and offset all of its greenhouse gas emissions from fossil fuels. City Light first achieved greenhouse gas neutrality in 2005 and has maintained that standard since. Most recently in 2016, City Council confirmed its resolve opposing the use of fossil fuels altogether in Resolution 31667. This resolution guides resource strategies to support clean and safe electricity production, opposing the use of fossil fuels and new nuclear energy in the generation of electricity. City Light's existing power supply resources, operations, and planning processes reflect the City's values to address climate change and be a good steward of the environment.

The City of Seattle is pursuing a goal of carbon neutrality by 2050 and the Seattle Climate Action Plan is the first step toward achieving that goal. (<http://www.seattle.gov/environment/climate-change>)



To support the Mayor's Drive Clean Seattle Initiative to combat climate change, City Light will implement three electric charging infrastructure pilot programs over the next several years. Starting in 2017, City Light will begin installing 10 to 20 public DC fast charging stations within its service territory, which will triple current availability. Also beginning in 2017, City Light will install Level II, 240V, stations in customers' homes and create a service that lowers the initial cost and uncertainty of installing at-home charging. Lastly, the City has committed to reduce greenhouse gas emissions from the municipal fleet 50 percent by 2025 through a significant investment in electric vehicles.



The current City Light portfolio is expected to be sufficient to meet increases in electric vehicle demand. Based on third-party projections, resulting load from plug-in electric vehicles for 2016 will be less than 3 average megawatts with load projections through 2030 totaling 14 average megawatts.

State Policies & Regulations

Washington State has always had been a strong voice for new laws and citizens' own initiatives regarding environmental priorities. Two examples impacting electric utilities are Electric Utility Resource Plans and the Energy Independence Act.

Electric Utility Resource Plans

The State, through ESHB 1010 (Chapter 195, Laws of 2006, Revised Code of Washington (RCW), Chapter 19.280) passed legislation in 2006 which requires certain Washington utilities, including City Light, to regularly prepare Integrated Resource Plans (IRPs). Under this law, IRPs must describe the mix of power supply resources and the energy efficiency needed to meet projected needs using available technologies, particularly renewable resource technologies. All of these must be balanced to offer the lowest reasonable cost to its ratepayers.

This process results in the formal Integrated Resource Plan that City Light reconsiders and updates every two years. The IRP is then reviewed by the public and stakeholders before going to the Seattle City Council where it is officially considered, discussed in public hearings, and adopted. Upon adoption, an action plan within the IRP sets into motion the new adjustments to City Light's electric portfolio.

The Energy Independence Act (Initiative 937)

A statewide citizen initiative (I-937) in 2006 passed another mandate that is now in state law, “The Energy Independence Act” (RCW, Chapter 19.285), requiring that City Light must acquire all cost-effective energy efficiency and also add higher levels of renewable resources to its portfolio.

For renewable resources, City Light has targets to serve 9% of retail load with eligible renewable generation by 2016 and 15% of retail load by 2020.

To meet I-937 requirements, eligible renewable energy must be sourced from within the Pacific Northwest or be purchased outside the Pacific Northwest and delivered to Washington on a firm transmission path, in real time, without integration services. Utilities may comply with I-937 by purchasing RECs.

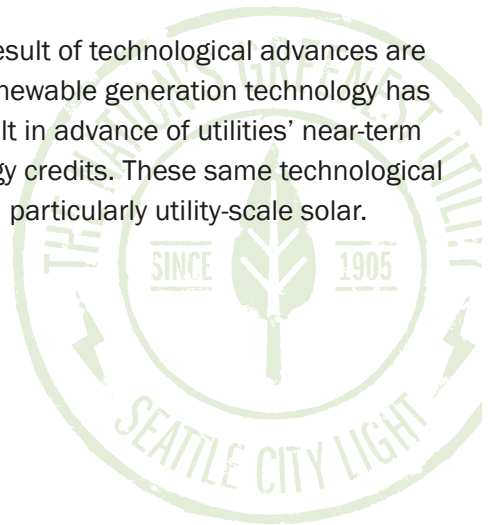
RECs are energy certificates: non-tangible energy commodities that represent proof that one megawatt hour (MWh) of electricity was generated from naturally replenishing (renewable) resources such as modern biomass, wind, solar, geothermal and biofuels. Washington State law specifically excludes hydropower as an eligible resource, but hydro efficiency upgrades can create qualifying renewable energy under I-937.

Regional Policies and Regulations

Similar to the City of Seattle and State of Washington, many states and localities have placed priorities on energy efficiency and renewable energy. City Light like other utilities throughout the West require renewable energy resources and renewable energy credits to meet state renewable portfolio standards.

Some of the most aggressive renewable portfolio standards today are in California and Oregon. Based on 2011 legislation, California electricity retailers are required to serve 20% of retail sales from renewable resources by the end of 2013, 25% by the end of 2016, and 33% by the end of 2020. In October 2015, new legislation increased the 2030 requirement from 33% to 50%. In Oregon, large utilities are expected to serve 25% of retail load with renewable resources in 2025, with the target recently increased to 50% of retail load by 2040.

Increases in renewable resource generation and low natural gas prices as a result of technological advances are reducing the energy prices in wholesale electricity markets. Additionally, as renewable generation technology has become more established and less costly, renewable generation has been built in advance of utilities’ near-term renewable generation requirements, driving down the cost of renewable energy credits. These same technological advancements have also been driving down the cost of renewable generation, particularly utility-scale solar.



Federal Policies and Regulations

Electric utilities are regulated by numerous federal regulations including the Clear Air Act, Clean Water Act and rules regulating electricity transmission and wholesale electricity sales. The federal government also licenses hydropower plants and ensures compliance. City Light's Boundary and Skagit Dams are licensed by the Federal Energy Regulatory Commission. Many of the regulations that fall under the Clean Air Act and Clean Water Act have significant impacts on the design, operation, and maintenance of fossil fuel power plants. These regulations impact utilities resource decisions.

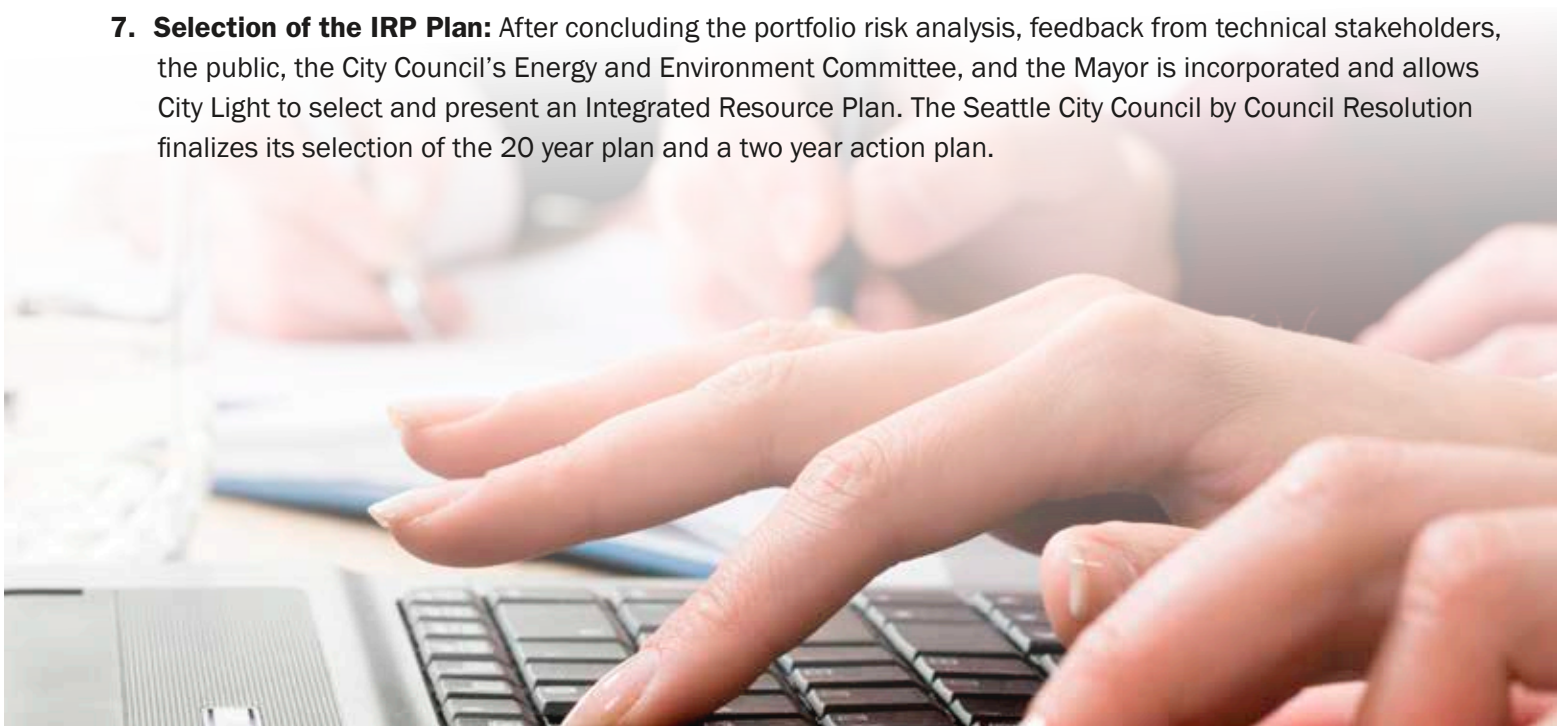
With climate change, federal regulation under the Clean Air Act is now targeting carbon dioxide pollution regulation. For many years utilities have speculated about when federal regulation of carbon dioxide emissions would occur. In 2013 President Obama announced his Climate Action Plan. Under this Plan, the president set new goals to establish carbon pollution standards for power plants. In 2014, the U.S. Environmental Protection Agency (EPA) released its Clean Power Plan proposed rule. The Clean Power Plan rule set targets to reduce carbon pollution from the power sector 32 percent below 2005 levels by 2030. On February 9, 2016 the Supreme Court stayed implementation of the Clean Power Plan after 15 states filed a complaint arguing the EPA overstepped its authority. Many states including Washington State are still continuing discussions to develop a plan for implementation. Unlike many other utilities, City Light will not have to alter its resource mix to comply with carbon regulation. Its resource mix does not include fossil fuels and City Light purchases offsets for its greenhouse gas emissions including those resulting from wholesale market purchases. City Light continues to anticipate that federal carbon regulation will change the resource mix for many utilities across the United States, making renewable resources more advantageous.



THE 2016 IRP PLANNING PROCESS

The following steps describe the process:

- 1. Existing Resource Portfolio:** Review existing supply to predict how well it will meet future demand. This includes representing impacts from operational constraints resulting from hydro license requirements; forecasting operations and maintenance and upgrade plans; and updating the analysis to include new contracts and contract renewals completed.
- 2. Load Forecast:** Forecast customers' future energy demand considering population, employment, and the economy, amongst other factors.
- 3. Identification of Resource Need:** Identify future supply needs over the next 20 years by evaluating the ability of existing supply to meet future forecasted demand, regulatory requirements and uncertainty in supply and demand. To help identify these needs City Light performs a resource adequacy assessment and forecasts its needs to comply with I-937.
- 4. Resource Choices:** Identify a wide range of commercially available utility-scale generating resources to meet future supply needs and forecast resource costs.
- 5. Candidate Portfolio Development:** Because the utility may need new supply over time, City Light is likely to add resources at different times over the 20 year study horizon. Portfolios are developed that add individual resources over time as needed. Candidate portfolios are constructed on a least-cost basis to meet reliability and I-937 requirements.
- 6. Portfolio Analysis:** Evaluates what resources City Light should use to meet customer demands based on how well those resources deliver reliability, environmental responsibility and cost efficiency while limiting risk.
- 7. Selection of the IRP Plan:** After concluding the portfolio risk analysis, feedback from technical stakeholders, the public, the City Council's Energy and Environment Committee, and the Mayor is incorporated and allows City Light to select and present an Integrated Resource Plan. The Seattle City Council by Council Resolution finalizes its selection of the 20 year plan and a two year action plan.



EXISTING RESOURCE PORTFOLIO

City Light's existing resource portfolio has been cultivated to be among the most environmentally responsible and low cost in the nation. Energy efficiency programs have contributed to reducing City Light's customer energy use, and currently equate to the addition of several large power plants.

This portfolio includes many past investments in energy efficiency, City Light owned hydropower resources, existing hydropower and renewable contracts from regional partners, and wholesale market purchases.

Figure 1 is a map of City Light's existing resources. City Light's power resources are 90 percent hydropower, approximately 50 percent of which is supplied by five hydroelectric projects owned and operated by the utility. Most of the remaining hydropower is purchased from the Bonneville Power Administration (BPA), a nonprofit federal power marketing agency. Beyond generating hydropower, City Light has the responsibility to operate its hydroelectric projects for flood control, fish management, and reservoir recreation. Additionally, in coordination with Seattle Public Utilities, two projects are operated for municipal water supply.

City Light Generation

- Located on the Pend Oreille River in northeastern Washington, Boundary Dam is City Light's largest resource. While the Boundary Project produces the most power and has substantial operational flexibility, it has only modest storage capacity.
- The Skagit Project includes the Ross, Diablo, and Gorge dams in the North Cascades. The Skagit Project has generous storage capacity.
- Additional power is provided by small hydro projects including Newhalem, South Fork Tolt, and the Cedar Falls dam.

Location of City Light's owned and contracted resources

Figure 1. Map of City Light's Owned and Contracted Resources



Contracted Resources

City Light's largest power purchase comes from BPA and is approximately 40 percent of City Light's supply. BPA markets wholesale electrical power from 31 federal hydroelectric projects in the Northwest, one nonfederal nuclear plant and several small nonfederal power plants. As one of BPA's "preference customers," City Light is entitled to a substantial amount of power from these sources. The current contract with BPA runs through September 2028. In this IRP, City Light analyzed the competitiveness of the BPA contract relative to other resource options.

The remaining contracts include:

- Under an 80-year agreement with the Canadian province of British Columbia, City Light abandoned plans to raise the height of Ross Dam in exchange for power purchases from British Columbia Hydro.
- City Light has contracted with Lucky Peak, a hydro project located near Boise, Idaho for over 30 years.
- City Light purchases power from the Priest Rapids Project under a 2002 agreement with Grant County Public Utility District.
- The Columbia Basin contracts include power from five Columbia River Basin hydroelectric projects. The projects are part of three irrigation districts, so electric generation is mainly in the summer months.
- Under an exchange agreement with the Northern California Power Agency (NCPA), City Light delivers energy to NCPA in the summer. In exchange, NCPA delivers energy to City Light in the winter.
- The Stateline Wind Project, on the Washington and Oregon border outside Walla Walla, Washington, provides wind-generated electrical energy and associated environmental attributes. This project meets I-937 requirements.
- City Light receives small amounts of biomass and landfill gas through Burlington Biomass, Columbia Ridge Landfill Gas Project, and King County West Point Wastewater Treatment Plant. These small projects qualify under I-937 as renewable energy.
- Seattle City Light also purchases power in the wholesale market to supplement its owned generation and contracted resources.



OWNED AND PURCHASED POWER RESOURCES FOR 2016

	Nameplate Capability (MW)	Energy Available Under Average Conditions (MWh)	Year FERC License Expires	Year Contract Expires
OWNED RESOURCES				
BOUNDARY PROJECT	1,119	3,423,010	2055	N/A
SKAGIT PROJECT				
Gorge	207	985,370	2025	N/A
Diablo	182	818,494	2025	N/A
Ross	450	828,565	2025	N/A
SMALL HYDRO PROJECTS	49	135,264	Varies	N/A
CONTRACTED RESOURCES				
BPA Block	N/A	2,349,845	N/A	2028
BPA Slice	N/A	2,682,195	N/A	2028
Priest Rapids	6	23,470	2052	2052
Columbia Basin	64	240,039	2030/2032	2022/2027
High Ross	N/A	310,271	N/A	2066
Lucky Peak	101	293,359	2030	2038
Stateline	175	371,162	N/A	2021
Small Renewables	20	205,772	N/A	Various

Figure 2. City Light's 2016 Sources of Power

Market Resources

City Light makes market sales and purchases in the wholesale electric power market. Market participation is particularly important to City Light because 90 percent of City Light's current resource portfolio is hydroelectric, which is highly variable, based on water availability and operating restrictions. Water conditions vary by season and year. Under average conditions, City Light has surplus energy throughout most of the year that can be sold in the electric market to offset costs. When there is not enough hydropower to meet demand, City Light makes market purchases for those instances.

Dry months or years can reduce water flows and cause the need to buy power, raising costs. At the same time, wet seasons or years may result in surplus water flow. City Light must also contend with a mismatch between the demand for hydropower and hydro's production peak. Spring snow melt drives hydropower production to peak in May. Yet Seattle's electricity demand peaks in the winter. Keeping sufficient power generation to meet winter demand can mean excess generation the rest of the year. In addition to this seasonal variation, precipitation may vary significantly from year to year, worsening the imbalance.

Figure 3 below shows how annual and monthly hydro generation for City Light's primary supply resources can vary significantly from year to year. Each line represents a single year between 1929 and 2008. The generation has been adjusted for today's operating constraints and shows the range of what could be generated with City Light's three largest resources: the Skagit Project, Boundary Dam and BPA Slice all combined.

Skagit, Boundary and BPA Slice Monthly Generation 1929 - 2008

Generation for Historic Water Conditions and Current River Regulations

**Average
Megawatts**

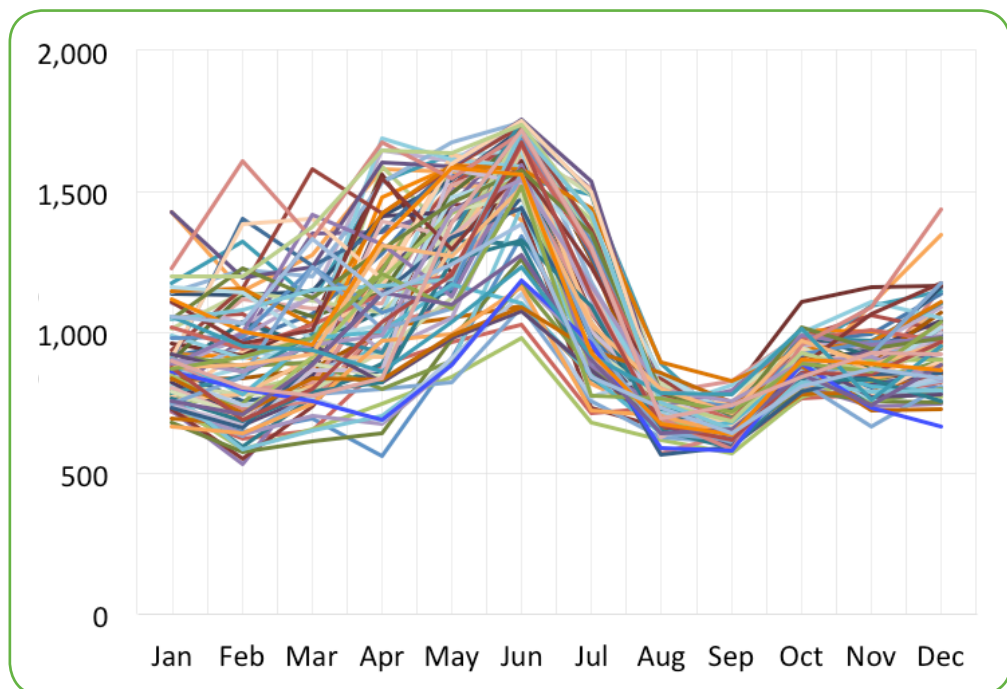


Figure 3. Seasonal and Annual Variability in City Light's Hydro Resources

Energy Efficiency

Energy efficiency was introduced into City Light's resource mix more than 30 years ago and has remained the utility's first-choice in meeting load growth. Energy efficiency programs encourage customers to use power more efficiently and allow the utility to defer the acquisition of expensive new resources, including those that negatively affect the environment. Energy efficiency is low cost and has low environmental impacts, including no greenhouse gas emissions. Integral to developing the IRP, energy efficiency programs will help City Light maintain its status as a greenhouse gas neutral utility, support the City's environmental and climate change policy goals, and meet the requirements of I-937.

For example, the average City Light residential customer today uses 8,000 kilowatt hours of electricity a year compared to 10,300 kilowatt hours per year in 2000.

Energy efficiency programs are designed for all customer classes and address specific energy end-uses such as lighting, water heaters, laundry appliances, HVAC, motors, and manufacturing equipment. These programs provide energy efficiency information and financial incentives that encourage customers, for example, to insulate their homes, install energy efficient appliances, or install efficient lighting in commercial and industrial establishments.



Seattle's Energy Code: Saves Money, Saves Electricity, Saves the Environment

The Seattle Energy Code has been consistently ranked among the most progressive codes in North America since its inception 36 years ago. Code concepts developed in Seattle are routinely incorporated into the Washington State Energy Code and increasingly into national standards. This code is one of the major reasons that City Light can plan on using its existing resources instead of adding new and costly electricity generation from other resources.

The Seattle Energy Code requires energy efficiency levels at least 20% better than the current national standard. This drives down energy costs by making high-performance buildings the local "business as usual".

New code provisions are vigorously debated and refined through a series of public meetings with local stakeholders to address cost-effectiveness and environmental stewardship.

Highlights of the 2015 Seattle Energy Code include:

- High-performance heating systems for commercial buildings
 - Prohibition of simultaneous heating and cooling in any one space
 - Daylight-responsive lighting controls in all daylight zones
 - Dimming of lighting in unoccupied stairwells and parking garages
 - Controlled receptacles in offices, classrooms and other spaces
 - Significant lighting power reductions, responding to the proliferation of LED lighting
 - Small photovoltaic array and larger "solar-ready" roof area required on commercial projects
 - Sub-metering and user dashboards required for medium and large-sized buildings
 - Energy upgrades in substantial renovation projects nearly to the efficiency levels required in new construction
-



LOAD FORECAST

The most critical step in future power planning is the determination of future power supply needs. For the purpose of the IRP, this involves an assessment of how much total energy City Light customers are expected to consume over a period of time (load), what is the maximum amount they are expected to consume instantaneously (peak demand) and how rapidly they are expected to change their instantaneous needs (flexibility or ramp).

The first step in assessing the need for additional resources is forecasting Seattle's future electricity demand and establishing a target for the desired level of resource adequacy. The Integrated Resource Plan's long-range forecast calls for continued load growth trends in electricity demand for the service area. This growth is primarily driven by projected economic and population growth for the region. Relative to previous IRP's, load growth is forecast to grow at a slower pace, due in part to changing regulations, building codes, and customer behaviors. This is similar to regional and national trends.

It should be noted that the IRP treats energy efficiency as a supply resource and evaluates energy efficiency in the same way as it evaluates other supply resources. As such, the graph below in Figure 4 shows the load forecast with historic energy efficiency, but without the impacts of new energy efficiency.

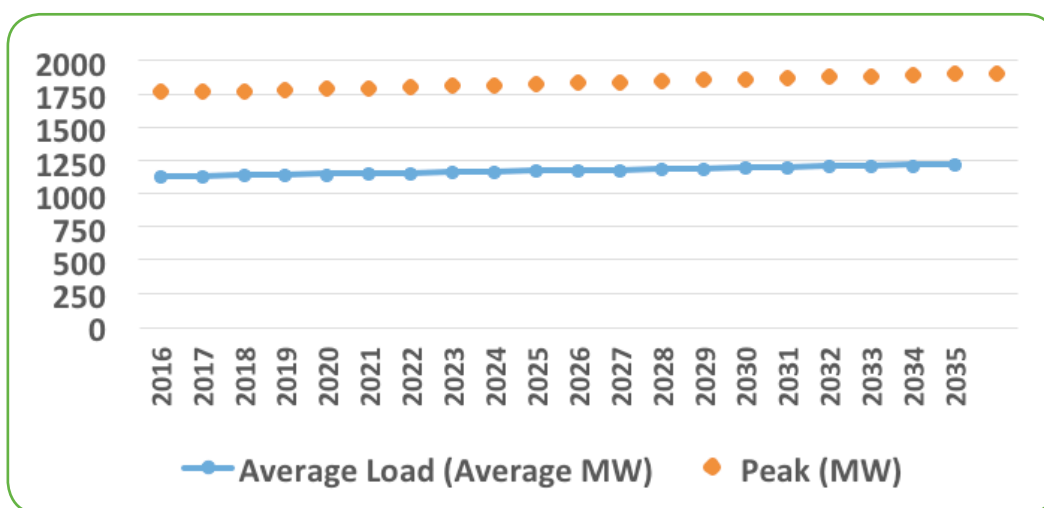


Figure 4. 2016 IRP Peak and Average Energy Load Forecast (Before New Energy Efficiency)



IDENTIFICATION OF RESOURCE NEEDS

As part of the IRP process, City Light identifies future supply needs for the next 20 years based on the ability of existing supply to meet future forecasted demand, regulatory requirements, and uncertainty in supply and demand. To help identify these needs City Light performs a resource adequacy assessment and forecasts how much eligible renewable generation will be needed to comply with I-937.

Resource Adequacy

Combining information about forecasted demand and existing resources, City Light determines whether it needs additional power supply resources for reliability. This is determined through a resource adequacy study. As a utility that relies on hydro generation, City Light established that it must have a high confidence measure of meeting resource needs to cover all circumstances which might develop – especially in high demand hours during the winter season. The 2016 IRP high confidence level is based on a 90% probability of being able to meet winter deficit conditions. It considers historical load variability, hydro generation variability, and the collective plans for maintenance and turbine overhauls, before appropriately adjusting its resource adequacy studies to account for circumstances that push the limit of City Light's capacity to meet every energy need.

City Light has maintained a high level of resource reliability, including the ability to serve demand even when hydro generation capability is low by using its option to purchase from the wholesale electricity market. City Light's analysis has determined reliance on 200 megawatts of short-term market purchases is appropriate. In an average water year (with normal temperatures) City Light has substantial surplus power available to sell in the wholesale power market, even during the winter months.

In addition to serving system load on an annual average basis, City Light must also have sufficient resources on a monthly, weekly and hourly basis. The greatest threat to City Light's resource reliability is the combination of low water and high customer demand for power. Low generation capability is usually due to drought conditions in the Pacific Northwest. High customer demand is usually due to extremely low temperatures in the winter. City Light's annual peak demand most often occurs in December or January. Including the decision to test the competitiveness of a future BPA contract and 200 megawatts of short-term market purchases, the 2016 IRP forecasts the utility will not need resources until 2028.



Figure 5 shows the load resource balance under expected conditions. The resource adequacy analysis identifies the amount of additional energy and capacity required to serve load. While this figure shows annual average need, City Light's flexibility with its hydro resources allow it to reshape generation to follow changes in load throughout the day. Additionally, the decision to allow a modest 200 megawatts of market purchases ensures City Light can meet peak winter demands under all probable cases.

Average Megawatts

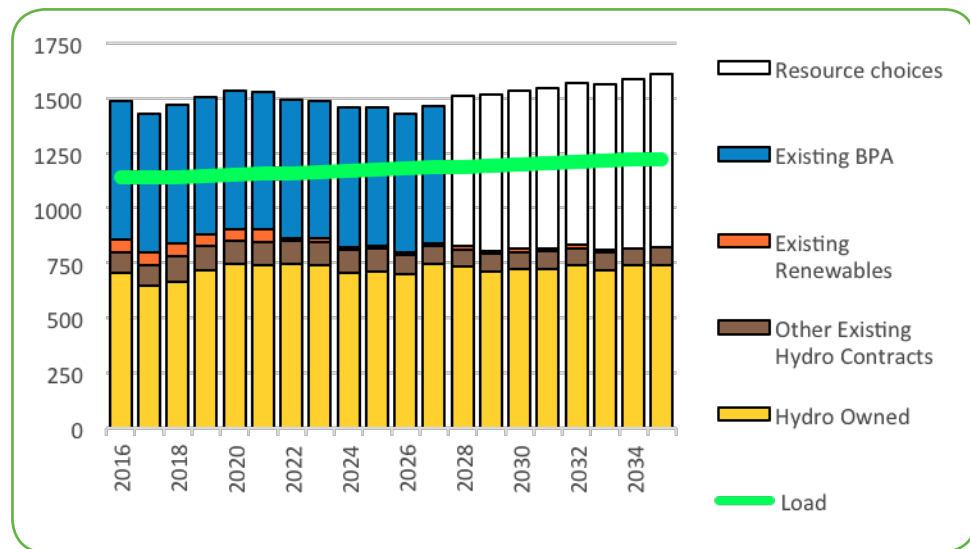


Figure 5. Expected Load Compared to Existing Resource Generation from 2016-2035

City Light will be demonstrating two projects to gain a better understanding of how these potential resources may play a role in meeting the needs of City Light's distribution network.

- In partnership with BPA, City Light is conducting a targeted demand response demonstration project using residential hot water heaters. This will help City Light and the region better understand demand response's potential for both peak shaving and renewables integration. Starting in 2017, approximately 100 customers will install a communications device capable of modifying energy consumption of their hot water heater. The communications device will receive a radio signal during demand response events and send data back via the customer's Wi-Fi network. City Light will target the customer recruitment in a tight geographic areas where there is a constraint on its distribution system.

- Seattle City Light will create a microgrid at a designated emergency shelter, powered by solar energy and a battery storage system. During an emergency, this stand-alone power grid will meet critical loads and keep the shelter operating.

I-937 Compliance

Under I-937, City Light must acquire all cost-effective energy efficiency and also add higher levels of renewable resources to its portfolio.

In 2013 City Light assessed the potential for energy efficiency to set a 2014-2015 energy efficiency target at 207,437 megawatt hours. Actual achievement was exceeded by over 60%. For the 2016-2017 biennium, City Light updated the target to 224,431 megawatt hours. This reflects a higher potential savings over the previous biennium.

For renewable resources, City Light has eligible renewable generation targets of 9% of retail load by 2016 and 15% of retail load by 2020. City Light expects to easily reach its 9% retail load goal with its Stateline Wind, biomass and landfill gas contracts, hydro efficiency upgrades at the Boundary and Gorge dams, and its multiple renewable energy credit contracts. To supplement this generation, City Light has also secured enough renewable energy and credits to ensure it will reach the 15% requirement by 2020. City Light's analysis forecasts it will be able to meet its renewable energy obligations for I-937 compliance through 2023.



RESOURCE CHOICES

City Light makes its resource decisions based on its citizens' priorities: low cost and low risk electricity generation, environmental stewardship, and reliability. City Light's customers, stakeholders, City Council and Mayor all express interest in reliance on energy efficiency and renewable resources in the utility's resource mix.

To meet the area's power supply needs as well as meet City Light goals (reliability, low-cost, low risk, and environmentally responsible), it's critical to understand the differences among the available resources in today's market. In many cases non-renewable resources are more reliable and cost-effective than renewable resources, but are less environmentally sensible.

Renewable Generation: Renewable resources satisfy the need for power and avoid the consumption of fossil fuels. In addition, renewable generation tends to avoid the emission of air and water pollution that endangers the environment and human health. The drawback of most renewable generation is the availability of fuel (water, sun, wind) as a result of weather fluctuations, making these resources less reliable. However, hydroelectric generation with storage provides reliability and flexibility in meeting resource needs.

Approximately 90% of City Light's power is generated by hydropower, including its hydroelectric facilities here in Washington State. However, for meeting I-937, freshwater electricity generation is excluded unless it results from qualifying hydro generation efficiency improvements.

Non-Renewable Generation: Non-renewable resources generally satisfy the need for power through the consumption of fossil fuels such as coal, oil and natural gas. City Light is required by RCW 19.280.030 to evaluate non-renewable generation as well as renewable generation. Most fossil fuel resources have the reliability advantage of being readily available to serve demand regardless of the weather. The most effective fossil fuel resource that can follow load is the natural gas combustion turbine. Natural gas combustion turbines can also provide necessary integration services to intermittent renewable generation, improving reliability of electric service.

City Light benefits from receiving clean hydro power from BPA power and transmission contracts; however, costs to produce and deliver this electricity have been rising and could alter the relative economics of future contracts and resource alternatives.

Market: Market purchases satisfy the need for power on a short-term basis to successfully meet reliability. City Light has the option of purchasing electricity from the wholesale western electricity market as needed.

Energy Efficiency: Energy efficiency is using less energy to provide the same service by using a different or upgraded technology. Figures 6 and 7 show the residential and commercial uses of energy where City Light expects to achieve the greatest savings through its energy efficiency programs. City policy and I-937 require energy efficiency choices. Certain energy efficiency measures can improve the load shape because their greatest effect is in the winter when electricity use tends to be greatest. Energy efficiency is the mainstay in both rounds of portfolio analyses, which examined base and high levels of achievement.

City Light benefits from receiving clean hydro power and being able to deliver electricity to demand from BPA power and transmission contracts; however, costs to produce and deliver this electricity have been rising and could alter the relative economics of future contracts and resource alternatives.

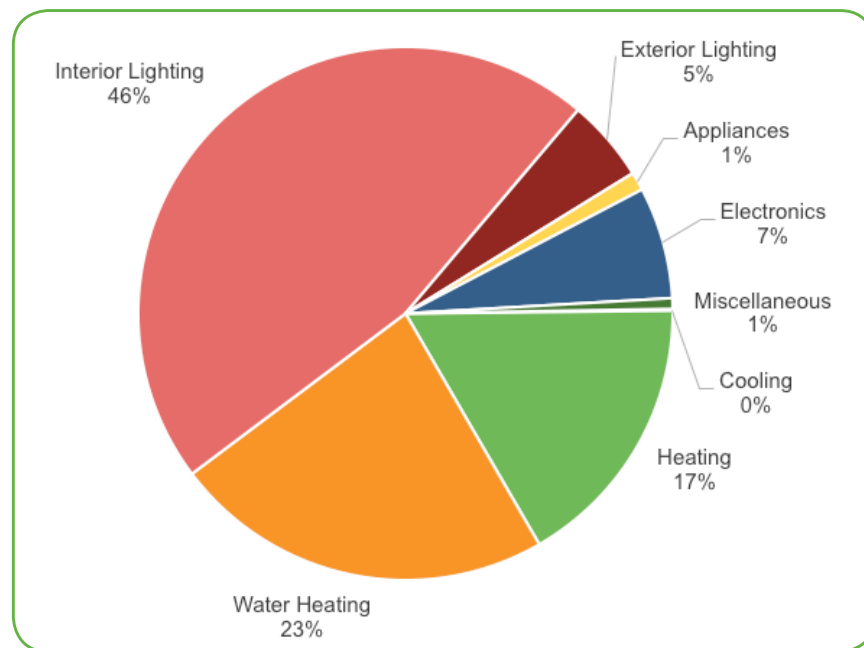


Figure 6. Achievable Residential Potential by End-use

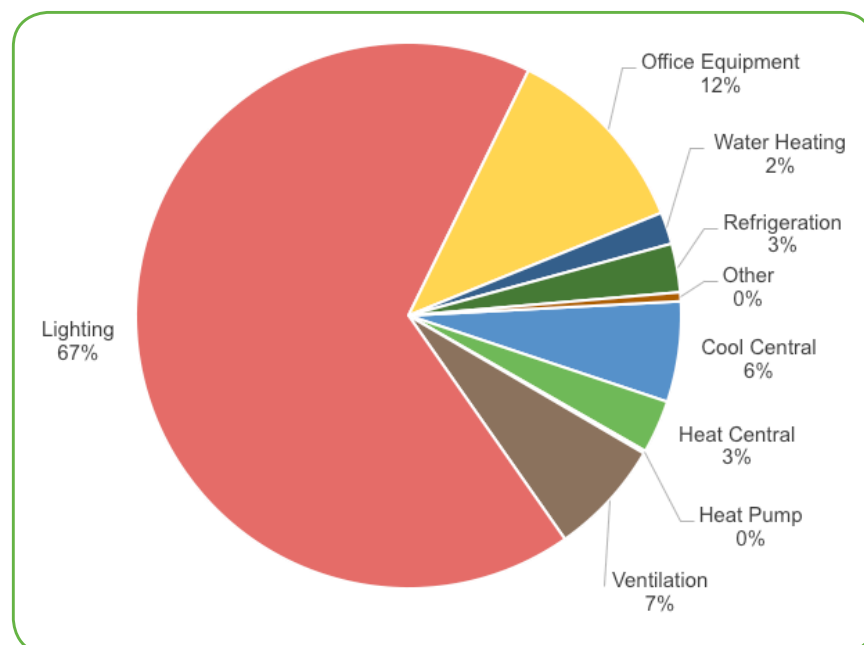


Figure 7. Achievable Commercial Potential by End-use

Resources Choices for the 2016 IRP

For the 2016 IRP the resources identified in Figure 8 are commercially available and proven technologies with reasonable costs and low environmental impact. This figure shows a relative comparison of each technology on an equivalent basis in dollars per megawatt hour. It represents a forecast of the annual cost per unit of energy produced for twenty years that City Light may expect to pay. Also, it includes recovery of the capital investment, operations, maintenance, emissions costs, shaping, and delivery of that energy to City Light. Many of these resource costs have been rapidly changing with technology advancements and adoption. City Light will continue to monitor developments in resource technologies for cost and commercial availability.

Seattle City Light 2016 New Resource Cost Projections

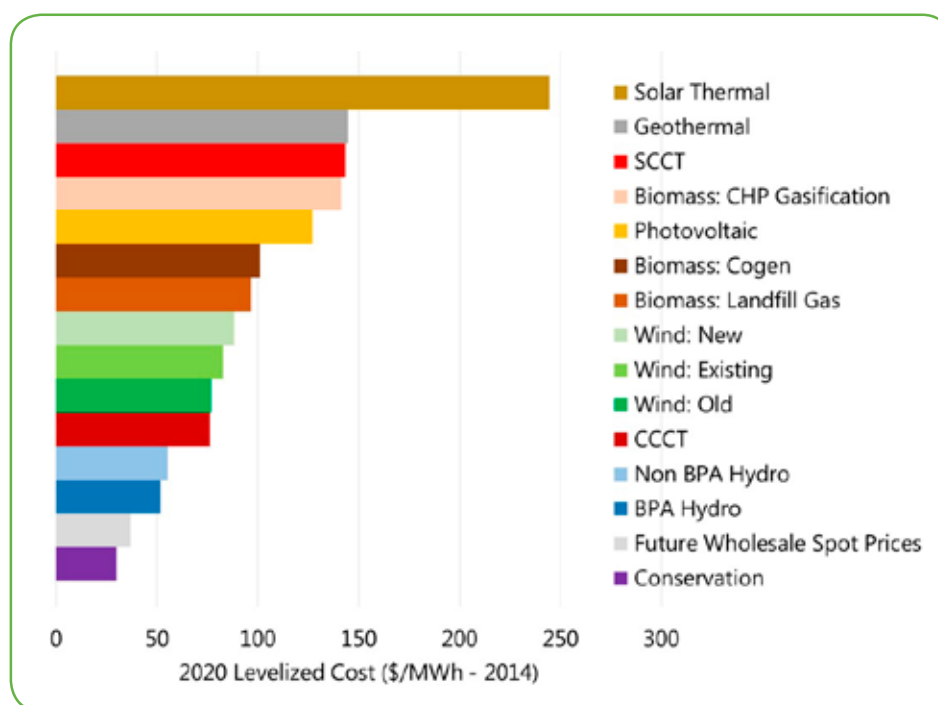


Figure 8. 2016 IRP New Resource Choices and Cost Projections – Projections From Early 2015



CANDIDATE PORTFOLIO CONSTRUCTION

The utility may need new supply over time, making a single resource option unrealistic. City Light may prefer to add resources as needed and when economically beneficial over the next 20 years or to meet environmental stewardship goals. To reflect the ability to add resources incrementally over time, candidate portfolios are developed that add individual resources over time. After portfolios are created, the utility performs analyses of each future candidate portfolio to measure the cost and financial risk.

In the case of this IRP, nine portfolios were constructed using a portfolio optimization tool to meet multiple objectives. Each portfolio was constructed to meet reliability and renewable resource levels to satisfy I-937. Additionally the portfolios reflect City of Seattle policies while testing the required broad range of resources required by the state rules for Integrated Resource Planning.

Figure 9 provides a summary description of each of the nine future IRP portfolios.

RESOURCE OPTIONS	IRP Candidate Portfolios								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
ENERGY EFFICIENCY									
Base	✓	✓		✓	✓	✓	✓	✓	✓
High Achievement			✓						
RENEWABLES									
RECs	✓	✓	✓	✓				✓	
Wind		✓	✓		✓		✓	✓	✓
Other renewables				✓	✓	✓	✓		✓
MARKET PURCHASE FLEXIBILITY									
Yes	✓	✓	✓	✓				✓	
No					✓	✓	✓		✓
BPA									
Existing contract as is								✓	✓
New BPA contract	✓	✓	✓	✓	✓	✓	✓		
NATURAL GAS (INCLUDES EMISSIONS COSTS)									
Yes	✓				✓	✓			✓
No		✓	✓	✓			✓	✓	

Figure 9. Comparison of Mix of Resources in IRP Resource Portfolio Options

PORTFOLIO ANALYSIS

The IRP portfolio analysis evaluates candidate portfolios that City Light should consider to meet customer demands based on how well those portfolios deliver reliability, environmental responsibility, and cost efficiency while limiting risk. First there is an initial evaluation to identify the leading contenders, then City Light conducts a further evaluation to help identify a preferred portfolio.

Initial Evaluation

The nine IRP portfolios are tested for cost and financial risk and calculated under expected conditions as well as conditions that deviate from the expected. The particular deviations from the expected that are tested include levels of demand, natural gas fuel prices, carbon dioxide costs, and water conditions. In total City Light examined ten scenarios, including the expected case. These scenarios help identify impacts and test the resilience of each portfolio.

- Cost is measured over the 20-year study period on a net present value basis. The cost includes generating and delivering power, offsetting emissions and pollutants to ensure City Light continues to remain greenhouse gas neutral. It also subtracts net sales of surplus energy in the market.
- Financial risk is measured based on annual cost volatility. The utility has identified a goal to reduce annual volatility to provide stable customer rates.

City Light seeks a final portfolio with a resource mix that reduces cost and risk. Figure 10 shows the relative performance of the nine portfolio options based on cost and risk. Portfolios with lower results for cost and risk perform better than portfolios with higher results. The results are based on how well the future portfolios performed in the ten scenarios. For example, if a single portfolio option performed the best in all ten scenarios, based on the cost measure, it would have a ranking of 10 for cost risk. Similarly if it performed the worst, it would have a ranking of 90 for cost risk.

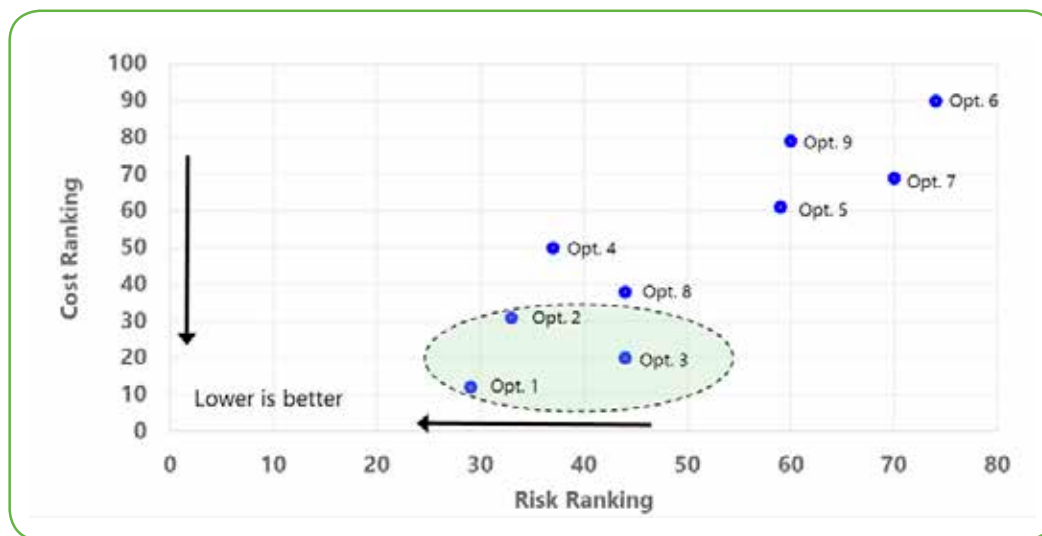


Figure 10. IRP Future Portfolio Options Cost and Risk Ranking

Key Findings

- All three top portfolios include a new BPA Hydro contract with a modest reduction in the energy purchased compared to the existing BPA contract.
- Each has similar amounts of reliable and cost-effective market purchase flexibility.
- RECs are a lower cost way to meet I-937 renewable needs before 2028 because of City Light's energy surpluses.



Further Evaluation and Risk Assessment

The 2016 IRP candidate portfolios were compared based on costs and risks and the top three performing portfolios were selected for further evaluation. The top three portfolios were subjected to probabilistic risk analyses that varied key drivers of cost and risk for City Light: the level of system load, the price of natural gas, and hydro conditions.

Hydro Conditions

City Light's strong reliance on hydropower makes hydro variability a significant concern to the utility. Hydro conditions on different river systems can be very different within the same year and City Light depends on multiple river systems. For the risk analysis, City Light models the levels of City Light's total hydroelectric production, maintaining the inter-relationships between the Skagit, Boundary, and Columbia River systems.

Electricity Demand

City Light is a winter peaking utility and pays particular attention to electricity demand during the coldest winter months. Seattle enjoys a relatively moderate marine climate, yet its location on the 47th parallel means that winter storms from the arctic or the Midwest can bring cold temperatures for periods typically lasting from several days to more than a week. The analysis of variability in demand is critical for resource planning.

Natural Gas Prices

Indirectly, natural gas prices have already had a large impact on City Light finances. With natural gas-fired generation as the price-setter for many hours in western power markets, power market prices and City Light's wholesale revenues tend to move up and down with natural gas prices. In 2008, natural gas prices reached over \$12 per million British thermal units (MMBtu). Lower demand for electricity and improved technology for recovery of shale gas have combined to drive prices down to the \$2 to \$3 per MMBtu range in the near-term. In the 2016 IRP, natural gas prices are not forecast to reach the 2008 highs within the 20-year planning period.

Probabilistic analysis allows City Light to examine over 2,800 outcomes for each of the top three portfolios. The results provide for further examination of the relative expected cost of the portfolios and a measure of financial risk based on the average of the top five percent worst outcomes (highest portfolio costs). This allows portfolios to be evaluated on whether they reduce these bad outcomes.

The results in order of lowest cost and risk are:

1. Portfolio Alternative #1: Base Energy Efficiency, Hydro and Gas with Market Purchase Flexibility
2. Portfolio Alternative #3: High achievement of Energy Efficiency, Hydro and Wind with Market Purchase Flexibility
3. Portfolio Alternative #2: Base Energy Efficiency, Hydro and Wind with Market Purchase Flexibility

The measurements of cost and risk in this analysis are very close since the portfolios are very similar. This is not surprising since the resource mixes are very similar in the early years with small adjustments to the resource mix in the later years relative to the size of the whole portfolio.

SELECTION OF THE 2016 INTEGRATED RESOURCE PLAN STRATEGY

The 2016 IRP analysis finds that City Light is well positioned to meet its needs into the future with continued achievement of programmatic energy efficiency. The “Portfolio Alternative #1: Base Energy Efficiency, Hydro and Gas” portfolio performed marginally better from a cost and risk perspective. However, this portfolio is not preferred because of the inclusion of a long-term natural gas resource contract and does not include additional renewable resources. City Council Resolution 30144 establishes a preference for cost-effective energy efficiency and renewable resources, and the basis for City Light to offset all of its greenhouse gas emissions from fossil fuels. Resolution 31667 includes a provision that opposes the use of fossil fuels.

The “Portfolio Alternative #2: Base Energy Efficiency, Hydro and Wind” portfolio and the “Portfolio Alternative #3: High achievement of Energy Efficiency, Hydro and Wind” portfolio both meet the objectives of the resolutions. “Portfolio Alternative #3: High achievement of Energy Efficiency, Hydro and Wind” performs better from a cost and risk perspective.

Based on the recommendation from stakeholders, its consistency with Seattle City Council policies, and its reasonable cost and risk, City Light identified the “High achievement of Energy Efficiency, Hydro, and Wind” portfolio as the preferred portfolio for planning purposes.

With resource needs being identified far into the future, City Light will continue its IRP process every two years, reevaluating its needs and options as future conditions may change. What will not change is City Light’s commitment to environmental stewardship and the new action plan reflects this commitment.

The following table shows the cumulative portfolio additions from the 2016 IRP preferred portfolio. The portfolio and two year action plan were reviewed and then approved by the Seattle City Council on August 1, 2016.



Recommended Cumulative Portfolio Additions from 2016 IRP
(Average Megawatts)

Cumulative Resource Additions	High achievement of Energy efficiency	New BPA Hydro	Wind	RECs (annual additions)
2016	14	0	0	0
2017	29	0	0	0
2018	46	0	0	0
2019	61	0	0	0
2020	78	0	0	0
2021	94	0	0	0
2022	108	0	0	0
2023	121	0	0	0
2024	133	0	0	2
2025	143	0	0	12
2026	152	0	0	11
2027	160	0	0	56
2028	167	492	56	0
2029	175	500	60	0
2030	182	500	60	8
2031	188	500	60	14
2032	193	500	60	15
2033	197	500	60	15
2034	201	500	66	27
2035	205	500	83	10

How does City Light believe climate change may change its future course?

City Light's 2016 Integrated Resource Plan includes early reviews of climate change impacts on City Light's water resources used for electricity generation and electricity demand. The projected climate change impacts available for study appear to fall within the range of what City Light already has encountered in streamflow fluctuations, dramatic shifts in market conditions, emergency conditions, or other circumstances faced in the past. City Light will continue to evaluate climate change impacts as new research emerges to ensure City Light is ready.



TWO-YEAR ACTION PLAN

To meet power supply needs, the City Light 2016 IRP recommends a long-term energy efficiency and power resource strategy along with a short-term plan. The recommended 2016 IRP Action Plan outlines the following steps:

- Continue high achievement of cost-effective energy efficiency, ever on the look-out for new technologies, energy efficiency programs, and market strategies.
- Continue to assess modeling inputs, assumptions and methodologies related to all work central to the IRP including load forecasts and how customer energy use is changing.
- Continue to engage BPA to limit rising contract costs and work with other regional partners to ensure the upcoming contract remains affordable into the future.
- Serve the retail load with City Light's existing resources portfolio, short-term market purchases, and other transactions to reshape seasonal energy demands as needed.
- Monitor new resource options including their costs and ability to meet City Light's future resource needs.
- Maintain an adept and active power marketing operation.
- Participate in power and transmission regional forums to ensure access to efficient wholesale markets and reliable transmission capacity for serving City Light customers.
- Continue environmental leadership including evaluation of factors that impact hydro generation, electricity demand, and fish populations as new information on the subject is available.

Are there wholesale electricity market changes emerging that City Light will need to consider for marketing its surpluses?

New market developments such as the Western Energy Imbalance Market may be an opportunity for City Light to find additional economic value for its customers. Market changes have been occurring because utilities are facing increasing costs to integrate large amounts of intermittent renewable generation. For the utilities participating, studies have shown reliability and economic benefits when "within the hour" changes in generation and load are added together and managed systematically across multiple participating utilities.



CONCLUSION: KEEPING THE LIGHTS ON

Seattle City Light is here to keep the lights on and more importantly, provide its customers with reliable, safe and affordable clean energy.

This process – the 2016 Integrated Resource Plan – has been a two year process to stay ahead of anticipated changes in supply and demand. The core findings include:

- Seattle City Light expects continued modest load growth despite the building surge visible in the utility's service area.
- Seattle City Light should continue its pursuit of cost-effective new energy efficiency.
- Seattle City Light can expect to meet its power supply needs with cost-effective new energy efficiency programs.
- Seattle City Light should continue to add renewable energy credits and renewable resources as necessary to meet renewable portfolio standard requirements mandated by I-937.
- Seattle City Light should continue to seek existing and new opportunities to maximize economic benefits from its clean and reliable hydro resources.
- Seattle City Light has been a leader in environmental stewardship for more than 30 years, making it ready – even a model – for responding to the increased impacts and changes which may be caused by climate change.



If you are interested in being part of an ongoing conversation with Seattle City Light on the direction, resources and choices to be made, please get in touch and you'll be given options for being involved. City Light will be exploring:

- Renewable resource improvements
- New and existing power supply technology
- Emerging policies and regulations from all levels of governments
- Research underway on climate
- How to get greater public involvement especially from diverse and underrepresented populations unfamiliar with the utility considerations

All present an exciting and ever-changing backdrop for the Integrated Resource Plan.

If you have comments, questions, ideas or want to be involved, please go to <http://www.seattle.gov/light/irp>.

Future IRPs

Many factors could influence the direction City Light takes in meeting power supply demands and determining customer costs. These include impacts to the cost of purchasing and selling power in wholesale energy markets, as well as changes in cost to develop and supply new generation to City Light's customers. These are the costs that need to be recovered through what the utility charges in its rates.

Federal and state financial incentives and market opportunities have offset some of the costs. Additionally, new renewable technology has become more efficient and cost competitive in recent years.

City Light's existing mix of energy efficiency, hydro and renewable generation has positioned City Light to be able to meet these regulatory requirements and policy objectives without modification to its existing resources for the foreseeable future. City Light's IRP, updated every two years, will continue to examine its portfolio to recognize if and when the mix of generating resources should be altered.

